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PTO/SB/05 (4/98)

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**UTILITY
PATENT APPLICATION
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(Only for new nonprovisional applications under 37 C.F.R. § 1.53(b))

Attorney Docket No.	MJ29US
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First Inventor or Application Identifier	Kia Silverbrook
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<i>Title</i>	Ink Jet Fault Tolerance Using Oversize Drops
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Express Mail Label No	EJ776408916US
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APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents

ADDRESS TO: Assistant Commissioner for Patents
Box Patent Application
Washington, DC 20231

1. ☒ * Fee Transmittal Form (e.g., PTO/SB/17)
(Submit an original and a duplicate for fee processing)

2. ☒ Specification [Total Pages]
(preferred arrangement set forth below)

- Descriptive title of the Invention
- Cross References to Related Applications
- Statement Regarding Fed sponsored R & D
- Reference to Microfiche Appendix
- Background of the Invention
- Brief Summary of the Invention
- Brief Description of the Drawings (*if filed*)
- Detailed Description
- Claim(s)
- Abstract of the Disclosure

3. ☒ Drawing(s) (35 U.S.C. 113) [Total Sheets]

4. Oath or Declaration [Total Pages 3]

- a. ☒ Newly executed (original or copy)
- b. ☐ Copy from a prior application (37 C.F.R. § 1.63(d))
(for continuation/divisional with Box 16 completed)
- i. ☐ DELETION OF INVENTOR(S)
Signed statement attached deleting
inventor(s) named in the prior application,
see 37 C.F.R. §§ 1.63(d)(2) and 1.33(b).

* NOTE FOR ITEMS 1 & 13: IN ORDER TO BE ENTITLED TO PAY SMALL ENTITY FEES, A SMALL ENTITY STATEMENT IS REQUIRED (37 C.F.R. § 1.27), EXCEPT IF ONE FILED IN A PRIOR APPLICATION IS RELIED UPON (37 C.F.R. § 1.28).

5. ☐ Microfiche Computer Program (*Appendix*)
6. Nucleotide and/or Amino Acid Sequence Submission
(*if applicable, all necessary*)
 - a. ☐ Computer Readable Copy
 - b. ☐ Paper Copy (identical to computer copy)
 - c. ☐ Statement verifying identity of above copies

ACCOMPANYING APPLICATION PARTS

7. ☒ Assignment Papers (cover sheet & document(s))
8. ☐ 37 C.F.R. § 3.73(b) Statement ☐ Power of Attorney
(when there is an assignee)
9. ☐ English Translation Document (if applicable)
10. ☐ Information Disclosure ☐ Copies of IDS
Statement (IDS)/PTO-1449 Citations
11. ☐ Preliminary Amendment
12. ☐ Return Receipt Postcard (MPEP 503)
(Should be specifically itemized)
- * Small Entity
13. ☒ Statement(s) ☐ Statement filed in prior application,
(PTO/SB/09-12) Status still proper and desired
14. ☐ Certified Copy of Priority Document(s)
(if foreign priority is claimed)
15. ☐ Other: _____

16. If a CONTINUING APPLICATION, check appropriate box, and supply the requisite information below and in a preliminary amendment:
- | | | | |
|---------------------------------------|-------------------------------------|---|--------------------------------------|
| <input type="checkbox"/> Continuation | <input type="checkbox"/> Divisional | <input type="checkbox"/> Continuation-in-part (CIP) | of prior application No. _____/_____ |
|---------------------------------------|-------------------------------------|---|--------------------------------------|

Prior application information. Examiner _____ Group / Art Unit: _____
For CONTINUATION or DIVISIONAL APPS only: The entire disclosure of the prior application, from which an oath or declaration is supplied under Box 4b, is considered a part of the disclosure of the accompanying continuation or divisional application and is hereby incorporated by reference. The incorporation can only be relied upon when a portion has been inadvertently omitted from the submitted application parts.

17. CORRESPONDENCE ADDRESS

- ☒ Customer Number or Bar Code Label 24011 or ☐ Correspondence address below
(Insert Customer No. or Attach bar code label here)

Name	Kia Silverbrook
	Silverbrook Research Pty Ltd

	393 Darling Street
--	--------------------

City	Balmain	State	NSW	Zip Code	2041
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<i>Country</i>	AUSTRALIA	<i>Telephone</i>	61-2-9818-6633	<i>Fax</i>	61-2-9818-6711
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Name (Print/Type)	Kia Silverbrook
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Registration No. (Attorney/Agent)

Signature

Date June 21, 2000

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**STATEMENT CLAIMING SMALL ENTITY STATUS
(37 CFR 1.9(f) & 1.27(c))--SMALL BUSINESS CONCERN**

Docket Number (Optional)
MJ29US

Applicant, Patentee, or Identifier: Silverbrook Research Pty Ltd
Application or Patent No.: _____
Filed or Issued: June, 2000
Title: Ink Jet Fault Tolerance Using Oversize Drops

I hereby state that I am

- ☒ the owner of the small business concern identified below:
☐ an official of the small business concern empowered to act on behalf of the concern identified below:

NAME OF SMALL BUSINESS CONCERN Silverbrook Research Pty. Ltd.

ADDRESS OF SMALL BUSINESS CONCERN 393 Darling Street, Balmain, NSW 2041, Australia

I hereby state that the above identified small business concern qualifies as a small business concern as defined in 13 CFR Part 121 for purposes of paying reduced fees to the United States Patent and Trademark Office. Questions related to size standards for a small business concern may be directed to: Small Business Administration, Size Standards Staff, 409 Third Street, SW, Washington, DC 20416.

I hereby state that rights under contract or law have been conveyed to and remain with the small business concern identified above with regard to the invention described in:

- ☒ the specification filed herewith with title as listed above.
☐ the application identified above.
☐ the patent identified above.

If the rights held by the above identified small business concern are not exclusive, each individual, concern, or organization having rights in the invention must file separate statements as to their status as small entities, and no rights to the invention are held by any person, other than the inventor, who would not qualify as an independent inventor under 37 CFR 1.9(c) if that person made the invention, or by any concern which would not qualify as a small business concern under 37 CFR 1.9(d), or a nonprofit organization under 37 CFR 1.9(e).

Each person, concern, or organization having any rights in the invention is listed below:

- ☒ no such person, concern, or organization exists.
☐ each such person, concern, or organization is listed below.

Separate statements are required from each named person, concern, or organization having rights to the invention stating their status as small entities. (37 CFR 1.27)

I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate. (37 CFR 1.28(b))

NAME OF PERSON SIGNING Kia Silverbrook

TITLE OF PERSON IF OTHER THAN OWNER _____

ADDRESS OF PERSON SIGNING 393 Darling Street, Balmain, NSW 2041, Australia

SIGNATURE [Signature] DATE June 21, 2000

INK JET FAULT TOLERANCE USING OVERSIZE DROPS

Field of the Invention

This invention relates to digital printing and more particularly to printing
5 using devices which eject ink onto the printed substrate. However, the invention is
not limited to ink ejection devices and is also applicable to laser, light emitting diode
printers and to digital photocopiers.

Background of the Invention

10 In ink ejection devices a printhead has an array of nozzles through which ink is selectively ejected onto the substrate as the substrate moves relative to the printhead. The printhead may print by scanning across the substrate to print horizontal bands or, if it is a full page width printhead, it may pass along the length of the page. A blocked nozzle will result in multiple horizontal blank lines, in the case of a scanning type printhead, or a blank vertical line in the case of a page width
15 printhead. Such blank lines are undesirable since they detract from the printed result.

The present invention provides a method of modifying the printing of an image so as to reduce or effectively eliminate the visual effect of one or more such blocked nozzles apparent to the eye of an observer in normal use. However, the invention is applicable to other forms of printing where a device, whether passive or active, is repeatedly used to produce dots of ink or the like on a substrate. The invention has potential application to laser and LED type printers and photocopiers where a fault in the imaging drum or light source can result in repeated faults in the image produced. As used above and throughout the description and claims the term image is to be understood to have a broad meaning and includes anything printed, such as text and line drawings.

Disclosure of the Invention

In one broad form the invention provides a method of modifying an image to be digitally printed by a printing device to compensate for failure to correctly print dots of ink at specific locations, the method including the steps of:

- a) identifying said specific location or locations, and
- b) adjusting the dot size of at least one a dot at a location adjacent or near to the respective specific location from that required by the image data.

In another broad form the invention provides a printer having a row of activatable devices which, when activated, cause rows of dots to be deposited onto a substrate and means to move the substrate relative to the row of devices in a direction generally perpendicular to the row of dots, said printer including:

- a) means to determine if one or more of said devices is not operating correctly; and
- b) control means for analysing images or image data and for identifying a specific location or locations where a dot of ink should be printed by activation of a incorrectly operating device and for adjusting the size of dot produced by one or both of the devices on either side of the failed device.

The incorrectly operating device will result in a defect line or lines in the image printed. Usually the incorrectly operating device will produce no ink or not enough ink and so a blank or faint line will be produced. To compensate adjacent ink dots will be caused to be larger than required by the raw image data. Conversely if the incorrectly operating device is producing oversized ink dots, the dot size of adjacent dots will be reduced.

Where a part of an image requires the incorrectly operating device to deposit a continuous or substantially continuous column of dots, the dots in adjacent columns are preferably all adjusted in size. If there are a small minority of locations in the column of the incorrectly operating device which do not require ink, dots in adjacent columns may or may not be adjusted in size.

Dots in more than the two adjacent columns may be adjusted in size. Dots in adjacent columns may be adjusted in size only if they are within predetermined vertical or horizontal distances or both of one or more specific location. For example only dots in the columns either side of the failed column may be adjusted in size but dots in those columns two or three rows above and/or below the respective location may be adjusted in size.

Brief Description of the Drawings

The invention shall be better understood from the following non-limiting description of preferred embodiments and the drawings, in which

Figure 1 shows a schematic illustration of a set of nozzles of an ink jet printing head.

Figure 2 shows a schematic illustration of an array of ink dots formed by the printhead of Figure 1 without fault correction operational.

Figure 3 shows a schematic illustration of the same array of ink dots as in Figure 2 formed by the printhead of Figure 1, but with fault correction operational.

Figure 4 shows a second schematic illustration of an array of ink dots formed by the printhead of Figure 1 without fault correction operational.

Figure 5 shows a schematic illustration of the same array of ink dots as in Figure 4 formed by the printhead of Figure 1 but with fault correction operational.

Description of Preferred and Other Embodiments

Referring to Figure 1, a printhead 10 has an array of ink jet nozzles 12 arranged in a single line. For the purpose of explanation only 14 nozzles are shown but in practice there will be from tens to thousands of nozzles arranged in a line. Paper is passed underneath the printhead in a direction generally perpendicular to the line of ink jet nozzles, as indicated by arrow 14. The printhead may be a stationary or a movable printhead. As the paper passes under the printhead the ink jet nozzles A to N are selectively operated to cause an array of ink dots to be placed on the paper. This array is a series of columns and rows, the spacing of which is dependent on the

spacing of the inkjet nozzles and the minimum paper feed step respectively. Whilst it is preferred that the horizontal and vertical spacing of the dots is the same, this is not necessarily achievable due to the different sources of the spacing. The printhead may be a page width printhead or a smaller printhead which scans across the page to lay
5 down a series of transverse bands of printing.

For the purposes of explanation it is assumed that inkjets a-g and i-n inclusive are operating correctly but, for whatever reason, inkjet h is not operating correctly or at all. It is also assumed that the diagnostic systems of the printer, which will be well understood by those skilled in the art, have detected that nozzle h is not functioning
10 correctly. In most cases, a malfunctioning device will be partially or totally blocked resulting in insufficient or no ink being deposited on the paper.

Referring to Figure 2, which schematically shows a portion of printing performed by the printhead 10 without fault correction, there is a blank column, labelled "h" corresponding to inkjet h, whilst columns a-g and i-n have been
15 correctly selectively printed. This leads to one or more blank lines appearing in the printing depending on whether the printhead 10 is a full page width printhead or a scanning type printhead. The unshaded circles numbered 16, 18, 20 and 22 represent drops of ink which should have been printed in column h but were not. Figure 3 shows the same image printed by the printhead 10 but with fault correction
20 according to an embodiment of the invention operational.

Referring to Figure 3 the ink drops in columns g and i are caused to be larger than normal, as will be explained below. This reduces the amount of white space between the dots and between the columns g and i. The effect is that the un-printed column h is not apparent to the eye of the user. When printing on A4 or letter size
25 paper for reading at normal distances, such as at 20 to 30cm, the effect occurs at about 1600dpi and upwards.

In the Figure 3 print, only dots intended to be printed anyway in columns g and i have been increased in size but it is within the scope of the invention that extra dots of ink, whether of normal size or of adjusted size, may be printed in the
30 columns either side of the failed column in locations when the image data does not

- 5 -

require a dot. As seen in figure 3 there are dots in the image at only about 50% of possible locations and so, even with oversize dots, there is still significant white space. This white space may be reduced by printing dots in vacant areas to reduce and/or break up the visual effect of the un-printed column

5 The area of each adjusted size dot is preferably increased by about 50% but this may be more or less, as needed. The oversize dots in the two columns may just touch dots in the same column. However, the size increase may be less, such that the dots in each of the two columns of dots do not join, or may be greater, such that adjacent dots overlap.

10 Where ink dots are required in column h at frequent intervals oversize drops will be deposited continuously by nozzles g and i. It will be appreciated that when ink dots are deposited less frequently the drop size of ink in columns g and i will only increase adjacent or near to areas where drops should occur in column h. These oversize drops may extend into rows where no ink is intended in column h. Where
15 ink is not intended in column h for large distances, preferably no oversize drops will be created in columns g and i.

Referring to figures 4 and 5 there are shown a second set of schematic prints without and with fault correction respectively. As seen in figure 4, dots of ink are required, but not printed, in column h at rows 1, 2, 3, 5 and 7, as indicated by open
20 circles 30, 32, 34, 36 and 38. In figure 5 dots in columns g and I are increased in size in rows above and below un-printed dots 30, 32, 34, 36 and 38. Because there are more dots in these columns than compared to the figure 2 and 3 prints, the oversize dots overlap more and reduce the white space to a greater extent. Again, if desired, normal or oversize dots may be printed in vacant locations, such as column g, rows 1
25 and 5 and column I rows 2, 3 and 7.

In the case of ink ejection type printers, increased dot size is achieved by increasing the amount of ink ejected. In the case of thermal ink ejection devices this may be achieved by increasing the duration of the heating current pulse. In the case of piezo electric ink ejection devices this may be by increasing the driving voltage or
30 current to cause greater distortion or by increasing the pulse duration. Similarly with

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mechanical type ink ejection devices the pulse width and/or driving voltage or current may be increased.

The invention is also applicable to situations where individual devices are producing too much ink, in which case the adjacent devices may be adjusted to
5 reduce the dot size of ink dots produced.

It will also be appreciated that this technique may be used with laser and LED printers and photocopiers and other types of digital printers where the placement of an ink dot is dependent on individual activation of a device or component. For example, an LED in a LED printer may fail or there may be a defect in the
10 photoconductive imaging drum of a laser printer. In both cases, adjusting the size of adjacent dots can hide or reduce the visual effect of the defect in the device or component.

In the case of a laser or light emitting device type printer dot size may be modified by modulating the intensity and or total amount of the light falling on the
15 corresponding portion of the photoelectric imaging drum.

I Claim:

1. A method of modifying an image to be digitally printed by a printing device to compensate for failure to correctly print dots of ink at specific locations, the method including the steps of:
 - 5 a) identifying said specific location or locations, and
 - b) adjusting the dot size of at least one a dot at a location adjacent or near to the respective specific location from that required by the image data.
2. The method of claim 1 wherein the dot size of said adjusted dot or dots is increased if no dot or an undersize dot is printed at the respective specific
10 location.
3. The method of claim 1 wherein the dot size of said adjusted dots is decreased if an oversize drop is printed at the respective specific location.
4. The method of claim 1 wherein dots located both transversely and longitudinally spaced from the respective location are adjusted in size.
- 15 5. The method of claim 1 wherein selected oversize adjusted dots contact or overlap adjacent dots.
6. The method of claim 1 wherein selected adjusted size dots do not contact or overlap adjacent dots.
7. A printer having a row of activatable devices which, when activated, cause
20 rows of dots to be deposited onto a substrate and means to move the substrate relative to the row of devices in a direction generally perpendicular to the row of dots, said printer including:
means to determine if one or more of said devices is not operating correctly;
and
25 control means for analysing images or image data and for identifying a specific location or locations where a dot of ink should be printed by activation of a incorrectly operating device and for adjusting the size of dot produced by one or both of the devices on either side of the failed device.

8. The printer of claim 7 wherein the control means adjusts the size of dots deposited in the same row as the respective specific location by one or both of the devices on either side of the failed device.
9. The printer of claim 7 wherein the control means adjusts the size of dots deposited by one or both of the devices on either side of the failed device at least one row adjacent or near to the row of the respective specific location.
10. The printer of claim 7 wherein if no dot or an undersized dot is produced by activation of the incorrectly operating device the size of dots produced by activation of one or both of the devices adjacent to the incorrectly operating device is increased.
11. The printer of claim 7 wherein the devices are thermo mechanical ink ejection devices and said control system causes the ejection devices to be activated for a longer period of time or supplies a larger driving signal, or both.
12. The printer of claim 7 wherein said devices are light emitting devices and wherein the amount of light emitted by said light emitting devices is adjusted.
13. The printer of claim 7 wherein said devices are portions of a photoconductive imaging drum and the dot size of said adjusted dots is adjusted by varying the amount of light the respective device is exposed to.
14. The printer of claim 7 wherein at least some oversize adjusted dots contact or overlap with adjacent dots.
15. The printer of claim 7 wherein adjusted size dots do not overlap contact with adjacent dots.

Abstract

A printing method identifies where parts of an image will not be printed correctly due to partial or total device failure and if possible adjusts the size of ink dots in adjacent rows or columns so as to lessen the visual effect of failure to print at the original location.

Fig. 3

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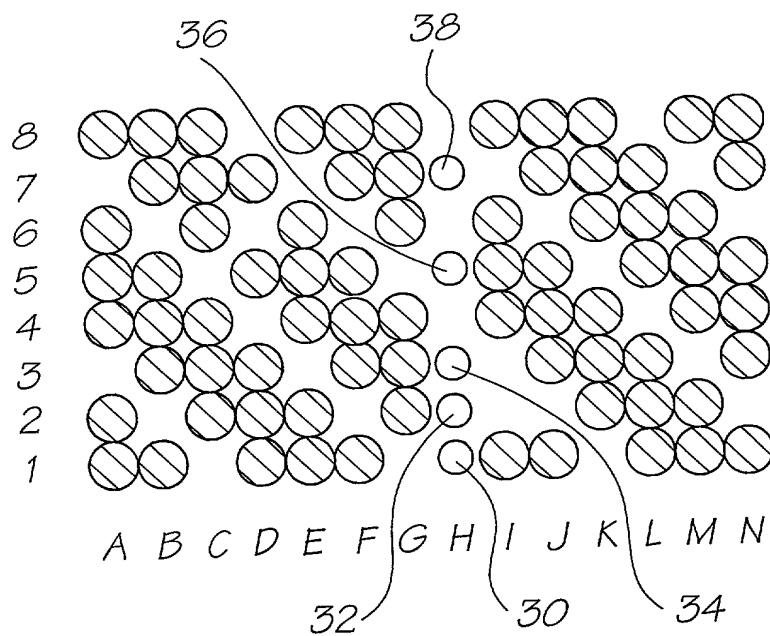


FIG. 4

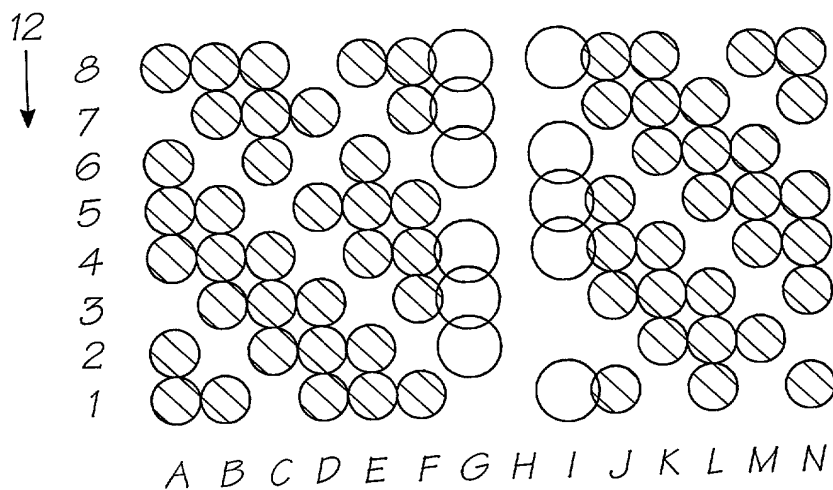


FIG. 5

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**DECLARATION FOR UTILITY OR
DESIGN
PATENT APPLICATION
(37 CFR 1.63)**

☒ Declaration Submitted with Initial Filing **OR** ☐ Declaration Submitted after Initial Filing (surcharge (37 CFR 1.16 (e)) required)

Attorney Docket Number MJ29US

First Named Inventor Kia Silverbrook

COMPLETE IF KNOWN

Application Number /

Filing Date

Group Art Unit

Examiner Name

As a below named inventor, I hereby declare that:

My residence, post office address, and citizenship are as stated below next to my name

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

Ink Jet Fault Tolerance Using Oversize Drops

the specification of which

(Title of the Invention)

☒ is attached hereto
OR

☐ was filed on (MM/DD/YYYY) as United States Application Number or PCT International

Application Number and was amended on (MM/DD/YYYY) (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment specifically referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56.

I hereby claim foreign priority benefits under 35 U.S.C. 119(a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or of any PCT international application having a filing date before that of the application on which priority is claimed.

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				YES	NO
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

☒ Additional foreign application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto:

I hereby claim the benefit under 35 U.S.C. 119(e) of any United States provisional application(s) listed below.

Application Number(s)	Filing Date (MM/DD/YYYY)	<input type="checkbox"/> Additional provisional application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto.

[Page 1 of 2]

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DECLARATION — Utility or Design Patent Application

I hereby claim the benefit under 35 U.S.C. 120 of any United States application(s), or 365(c) of any PCT international application designating the United States of America, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of 35 U.S.C. 112, I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

U.S. Parent Application or PCT Parent Number	Parent Filing Date (MM/DD/YYYY)	Parent Patent Number (if applicable)

☐ Additional U.S. or PCT international application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto.

As a named inventor, I hereby appoint the following registered practitioner(s) to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith.

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 OR
☐ Registered practitioner(s) name/registration number listed below

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☐ Additional registered practitioner(s) named on supplemental Registered Practitioner Information sheet PTO/SB/02C attached hereto.

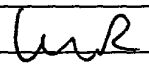
Direct all correspondence to: ☒ Customer Number or Bar Code Label OR ☐ Correspondence address below

Name	Kia Silverbrook				
Address	Silverbrook Research Pty Ltd				
Address	393 Darling Street				
City	Balmain	State	NSW	ZIP	2041
Country	Australia	Telephone	61-2-9818-6633	Fax	61-2-9818-6711

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Name of Sole or First Inventor: ☐ A petition has been filed for this unsigned inventor

Given Name (first and middle (if any))	Family Name or Surname
Kia	Silverbrook

Inventor's Signature		Date	June 21 2000
Residence: City	Balmain	State	NSW
	Country	Australia	Citizenship
			lian

Post Office Address	393 Darling Street				
Post Office Address					
City	Balmain	State	NSW	ZIP	2041
	Country	Australia			

☐ Additional inventors are being named on the supplemental Additional Inventor(s) sheet(s) PTO/SB/02A attached hereto